

CLAIMS

What is claimed is:

- 1 1. A tunable laser, comprising:
 - 2 a gain medium having an active emission layer to generate optical energy, the
 - 3 active emission layer having a first and a second facet;
 - 4 a first waveguide extending from the first facet, the first waveguide including a
 - 5 first core, the first core having a first end adjacent to the first facet for receiving optical
 - 6 energy, the first core fabricated from inorganic material and the first waveguide including
 - 7 inorganic material and thermo-optical organic material surrounding the first core;
 - 8 a second waveguide extending from the second facet, the second waveguide
 - 9 including a second core, the second core having a first end adjacent to the second facet
 - 10 for receiving optical energy, the second core fabricated from inorganic material and the
 - 11 second waveguide including inorganic material and thermo-optical organic material
 - 12 surrounding the second core;
 - 13 a substrate supporting the first waveguide, the second waveguide, and the gain
 - 14 means;
 - 15 a first reflector positioned to reflect optical energy propagating along the first
 - 16 waveguide if the optical energy has a wavelength that is one of a plurality of first
 - 17 reflection wavelengths;

18 a second reflector positioned to reflect optical energy propagating along the
19 second waveguide if the optical energy has a wavelength that is one of plurality of second
20 reflection wavelengths;
21 a thermo-optical organic material positioned to shift the plurality of first and
22 second reflection wavelengths in response to changes of temperature in the thermo-
23 optical organic material; and
24 a first thermal actuator thermally coupled to change the temperature in the thermo-
25 optical organic material.

1 2. The tunable laser of claim 1 wherein the first waveguide includes a reflector-
2 free portion interposed between the first end of the first core and the first reflector, the
3 reflector-free portion including a phase control section.

1 3. The tunable laser of claim 2 further comprising thermo-optical organic material
2 positioned in proximity to the phase control section.

1 4. The tunable laser of claim 3 wherein the thermo-optical organic material has a
2 coefficient of refractive index variation as a function of temperature, the magnitude of
3 which exceeds $1 \times 10^{-4}/^{\circ}\text{C}$.

1 5. The tunable laser of claim 3 wherein the thermo-optical organic material is
2 selected from the group comprising a polymer derived from methacrylate, a polymer

3 derived from siloxane, a polymer derived from carbonate, a polymer derived from
4 styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

1 6. The tunable laser of claim 1 wherein the first thermal actuator is selected from
2 the group comprising a resistive heater, a thermoelectric heater, and a thermoelectric
3 cooler.

1 7. The tunable laser of claim 3 wherein the first thermal actuator is coupled to
2 change the temperature in the thermo-optical organic material adjacent to the phase
3 control section, and further comprising:
4 a second thermal actuator is coupled to change the temperature in the thermo-
5 optical organic material adjacent to the first reflector; and
6 a third thermal actuator is coupled to change the temperature in the thermo-optical
7 organic material adjacent to the second reflector.

1 8. A tunable hybrid laser, comprising:
2 a substrate fabricated of a first material;
3 a gain medium fabricated of a second material and mounted onto the substrate, the
4 gain medium including an active emission layer to generate optical energy, the active
5 emission layer having a first and a second facet;
6 a first waveguide disposed on the substrate and extending from the first facet, the
7 first waveguide including a first core, the first core having a first end adjacent to the first

8 facet for receiving optical energy, the first core fabricated from inorganic material and the
9 first waveguide including inorganic material and thermo-optical organic material
10 surrounding the first core;

11 a first reflector positioned to reflect optical energy propagating along the first
12 waveguide if the optical energy has a wavelength that is one of a plurality of first
13 reflection wavelengths;

14 a second waveguide disposed on the substrate and extending from the second
15 facet, the second waveguide including a second core, the second core having a first end
16 adjacent to the second facet for receiving optical energy, the second core fabricated from
17 inorganic material and the second waveguide including inorganic material and thermo-
18 optical organic material surrounding the second core;

19 a second reflector positioned to reflect optical energy propagating along the
20 second waveguide if the optical energy has a wavelength that is one of a plurality of
21 second reflection wavelengths;

22 a thermo-optical organic material positioned to shift the plurality of first and
23 second reflection wavelengths in response to changes of temperature in the thermo-
24 optical organic material; and

25 a first thermal actuator thermally coupled to change the temperature in the thermo-
26 optical organic material.

1 9. The tunable hybrid laser of claim 8 wherein the first waveguide includes a
2 reflector-free portion interposed between the first end of the first core and the first
3 reflector, the reflector-free portion including a phase control section.

1 10. The tunable hybrid laser of claim 9 further comprising thermo-optical organic
2 material positioned in proximity to the phase control sections.

1 11. The tunable hybrid laser of claim 8 wherein the first thermal actuator is
2 selected from the group comprising a resistive heater, a thermoelectric heater, and a
3 thermoelectric cooler.

1 12. The tunable hybrid laser of claim 9 wherein the first thermal actuator is
2 coupled to change the temperature in the thermo-optical organic material adjacent to the
3 phase control section, and further comprising:
4 a second thermal actuator is coupled to change the temperature in the thermo-
5 optical organic material adjacent to the first reflector; and
6 a third thermal actuator is coupled to change the temperature in the thermo-optical
7 organic material adjacent to the second reflector.

1 13. The tunable hybrid laser of claim 8 wherein the first material is selected from
2 the group comprising sapphire, gallium arsenide, indium phosphide, silicon, glass,
3 ceramic, and metal.

1 14. The tunable hybrid laser of claim 8 wherein the second material is selected
2 from the group comprising sapphire, gallium arsenide, and indium phosphide.

1 15. A tunable laser, comprising:
2 a gain medium including an active emission layer to generate optical energy, the
3 active emission layer having a facet;
4 a waveguide extending from the facet, the waveguide including a core, the core
5 having an end adjacent to the facet for receiving optical energy, the core fabricated from
6 inorganic material and the waveguide including inorganic material and thermo-optical
7 organic material surrounding the core;
8 a substrate supporting the gain medium and the waveguide;
9 a reflector positioned to reflect optical energy propagating along the waveguide if
10 the optical energy has a wavelength that is one of a plurality of reflection wavelengths;
11 thermo-optical organic material positioned to shift the plurality of reflection
12 wavelengths in response to changes of temperature in the thermo-optical organic material;
13 and
14 a first thermal actuator thermally coupled to change the temperature in the thermo-
15 optical organic material.

1 16. The tunable laser of claim 15 wherein the waveguide includes a reflector-free
2 portion interposed between the end and the reflector, the reflector-free portion including a
3 phase control section.

1 17. The tunable laser of claim 16 further comprising thermo-optical organic
2 material positioned in proximity to the phase control section.

1 18. The tunable laser of claim 17 wherein the thermo-optical organic material has
2 a coefficient of refractive index variation as a function of temperature, the magnitude of
3 which exceeds $1 \times 10^{-4}/^{\circ}\text{C}$.

1 19. The tunable laser of claim 17 wherein the thermo-optical organic material is
2 selected from the group comprising a polymer derived from methacrylate, a polymer
3 derived from a siloxane, a polymer derived from carbonate, a polymer derived from
4 styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

1 20. The tunable laser of claim 15 wherein the first thermal actuator is selected
2 from the group comprising a resistive heater, a thermoelectric heater, and a thermoelectric
3 cooler.

1 21. The tunable laser of claim 16 wherein the first thermal actuator is coupled to
2 change the temperature in the thermo-optical organic material adjacent to the phase
3 control section, and further comprising:
4 a second thermal actuator is coupled to change the temperature in the thermo-
5 optical organic material adjacent to the first reflector; and
6 a third thermal actuator is coupled to change the temperature in the thermo-optical
7 organic material adjacent to the second reflector.

1 22. The tunable laser of claim 15 wherein the core further comprise a taper
2 adjacent to the first end for receiving optical energy.

1 23. An integrated optical component, comprising:
2 a waveguide disposed on a substrate and including a core having an end for
3 receiving optical energy, the core fabricated from inorganic material and the waveguide
4 including an inorganic material and thermo-optical organic material surrounding the core;
5 a first reflector positioned to reflect optical energy propagating along the
6 waveguide if the optical energy has a wavelength that is one of a plurality of first
7 reflection wavelengths;
8 a second reflector positioned to reflect optical energy propagating along the
9 waveguide if the optical energy has a wavelength that is one of plurality of second
10 reflection wavelengths;

11 thermo-optical organic material positioned to shift the plurality of first and second
12 reflection wavelengths in response to changes of temperature in the thermo-optical
13 organic material; and
14 a thermal actuator coupled to change the temperature in the thermo-optical
15 organic material.

1 24. The integrated optical component of claim 23 wherein the waveguide
2 includes a reflector-free portion interposed between the end and the first reflector and
3 between the first reflector and the second reflector, the reflector-free portions including a
4 phase control section.

1 25. The integrated optical component of claim 24 further comprising thermo-
2 optical organic material positioned in proximity to the phase control sections.